A role for gliders in sustained observations on the eastern boundary of the subtropical Atlantic

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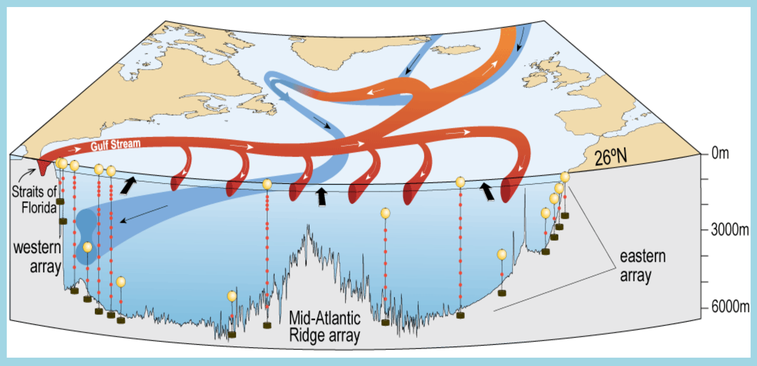
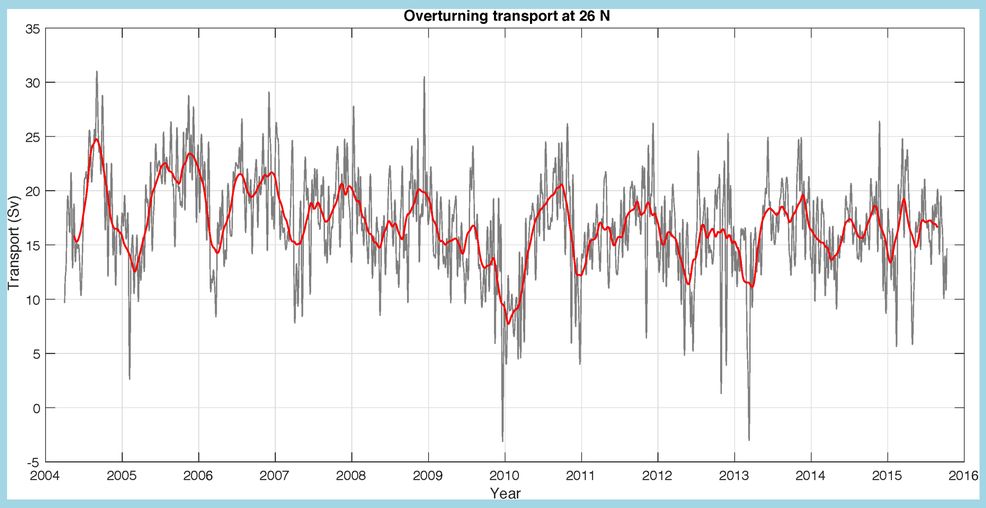
The RAPID-MOC array

The objective of the RAPID programme is to continuously observe the strength and structure of the Atlantic meridional overturning circulation (MOC). Observations have been made continuously since 2004

There are three main components of the MOC: the Gulf Stream is measured in the Florida strait, the Ekman transport is derived from surface winds and the geostrophic flow east of the Bahamas.



To monitor the geostrophic component requires measurements of temperature and salinity along the ocean boundary. These are made with an array of moorings on the eastern boundary, over the mid-Atlantic Ridge and on the western boundary.

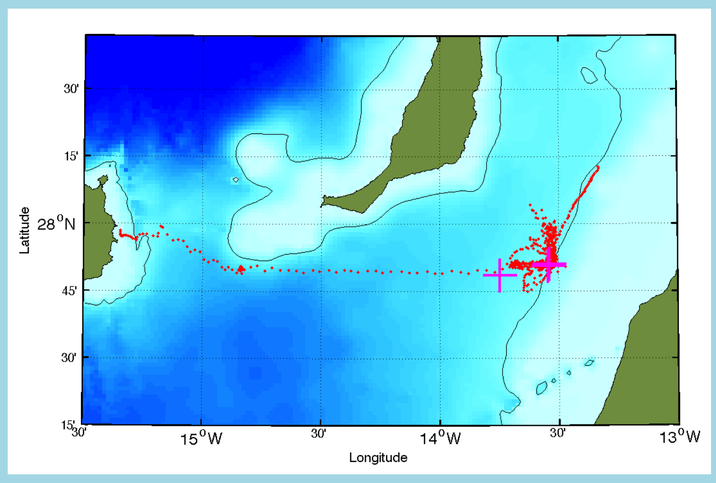


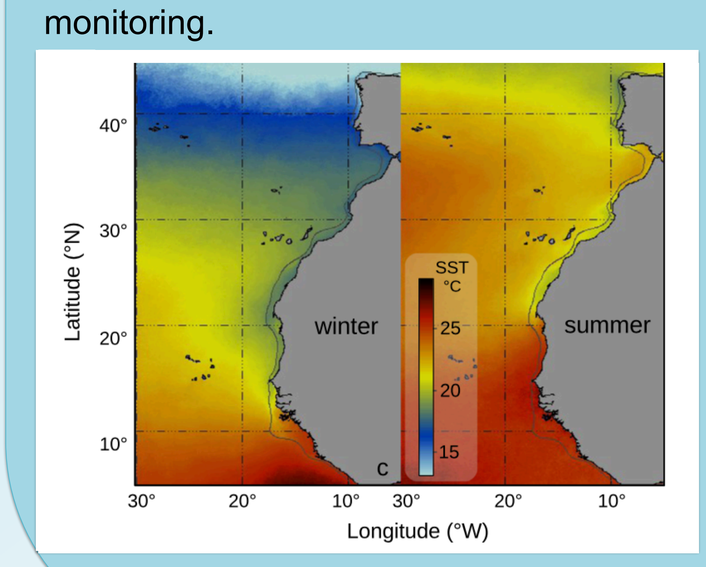
Download data from the RAPID program at
http://www.rapid.ac.uk/rapidmoc

The eastern boundary

The upper 1000m on the eastern boundary contributes a large proportion of the AMOC variability on the seasonal timescale. This variability is predominantly due to changes in wind forced upwelling.

Gliders have been deployed from the eastern coast of Gran Canaria from where they transit to the measurement site on the continental slope off Morocco. Red dots = glider profiles, magenta crosses = mooring locations. The transit to the measurement site takes about one week so at least two vehicles are required for continuous monitoring.





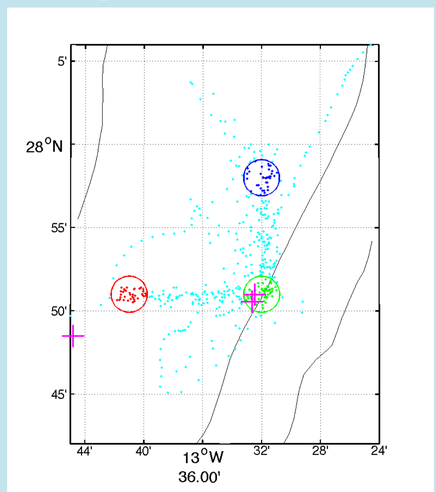
Upwelling also brings nutrient rich waters to the surface. This results in elevated productivity over the shelf and shelf edge that sustains large fisheries.

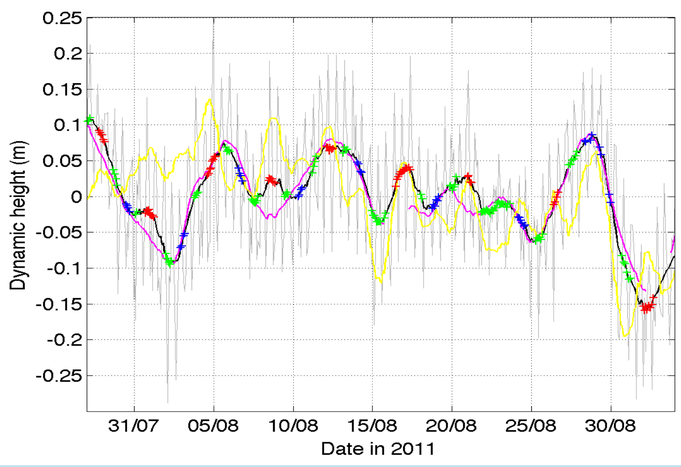
The Figure shows climatological sea-surface temperature distribution in winter and in summer.

Sampling strategies

Several different sampling strategies have been tried. There is significant variability associated with the internal tides and with mesoscale motions with periods of a few days.

In this example an L-shape was used in an attempt to calculate northward and eastward geostrophic velocities. Dots = locations of glider profiles, crosses = moorings and black contours show bathymetry. However, comparison with mooring data in the adjacent plot shows that it would be hard to determine spatial gradient from the glider data alone.





The figure shows the dynamic height difference between 200m and 800m
- **Gray** = glider data before removal of internal tide.
- **Black** = de-tided glider data, colored symbols indicate the locations as shown on the map above.
- **Magenta** = corresponding data from mooring.
- **Yellow** = dynamic height difference 10m to 110m from glider

Conclusions

So far 6 glider deployments totaling 292 days at sea have been made on the eastern boundary of the subtropical Atlantic. Compared with moorings gliders have the following:

Advantage:
- Near-surface measurements add significant additional risk to moorings and are often not made. Furthermore moorings may suffer from 'knockdown' when currents are strong. Gliders are able to measure up to the ocean surface. A large part of dynamic height variability occurs in the upper 100m.

Disadvantage:
- Overall reliability of gliders is not yet sufficient to achieve a high certainty of continuous coverage when only one vehicle is deployed at a time. One half of the deployments had to be terminated prematurely due to technical problems (either leaks or battery issues).

Comparison of the glider and mooring data reveals a variable cross-slope dynamic height gradient. However, using glider data alone separation of spatial and temporal variability could not be achieved. Using two vehicles would enable separation of spatial and temporal variations and provide increased reliability.

It is hoped that these observations may be sustained in the future through a co-operation between the UK, Spain and Morocco.

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